# Selected Soil Enzyme Activities in an Oak-Hickory Forest Following Long-Term Prescribed Burning

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## INTRODUCTION

The biochemical reactions within the soil are mediated by soil flora and fauna, and are catalyzed by enzymes. Therefore, enzymes play a significant role in nutrient cycling. Enzymes are specific for the type of chemical reactions in which they participate. Arylsulfatase is the enzyme that catalyzes the hydrolysis of an arylsulfate anion by fission of the oxygen-sulfur (0-5) bond. α-Glucosidase catalyzes the hydrolysis of α-D-glucopyranosides and is involved in the hydrolysis of maltose. β-Glucosidase catalyzes the hydrolysis of β-D-glucopyranosides and is involved in the hydrolysis of cellobiose. The hydrolysis products of glycosidases are believed to be an important energy source for microorganisms in soils (Tabatabai, 1982). Acid phosphatase mediates the release of inorganic phosphorus (P) from organically-bound P returned to the soil as litter and other organic debris. Urease catalyzes the hydrolysis of urea to carbon dioxide and ammonia. It acts on carbon-nitrogen (C-N) bonds other than the peptide linkage. Urease is important in organic N mineralization (Tabatabai, 1982).

Although the effect of prescribed burning on nutrient availability and cycling in forest soils has been investigated by many workers (Wells, 1971; Stark, 1973; Vance and Henderson, 1984; Weetman et al., 1990; Marion et al., 1991) little is known about the effect of fire on the activities of important soil enzymes. The objective of this study was to evaluate the effect of long-term burning on the activities of arylsulfatase, acid phosphatase, α- and β-glucosidases, and urease.

## MATERIALS AND METHODS

Soil samples were collected from a long-term burning experiment in southeastern Missouri. Even-aged stands of post oak (*Quercus stellata*), black oak (*Quercus velutina*), southern red oak (*Quercus falcata*), scarlet oak (*Quercus coccinea*), and hickory (*Carya* spp.) occupy the site. The burning experiment was established in 1949. The experiment consists of three treatments: (1) "annual burning", (2) "periodic burning" (every four years), and (3) "control". The soil is classified as a Typic Fragiudalf. Samples were collected in May 1992, a month after the "annual burning" treatment. Each plot was divided into 16 equally spaced areas and the soil was sampled (top 15cm) after removing the $O_1$ horizon. Samples for each plot were mixed and stored in plastic bags at 5 °C.

Acid phosphatase activity was determined using a method developed by Eivazi and Tabatabai (1977). The method of Tabatabai and Bremner (1970) was used for assaying arylsulfatase activity. α- and β-Glucosidase activities were determined by the method of Tabatabai (1982). These standard procedures involve colorimetric determination of *p*-nitrophenol released when soil is incubated with toluene and the respective buffered substrates for one hour at 37 °C. The urease

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activity was determined by a method described by Tabatabai and Bremner (1972). This method involves estimation of the ammonium ($NH_4^+$) released on incubation of toluene-treated soil with buffered urea solution.

An analysis of variance of the data was made, and Duncan's Multiple Range Test was used for comparing means at 5% probability level.

## RESULTS

Burning treatments, annual and periodic, did not affect the pH, organic C content, and β-glucosidase activity (Table 1). The activity of α-glucosidase, on the other hand, was reduced significantly by burning treatments, with annual burn showing a marked reduction of the activity of this enzyme. Acid phosphatase activity was also significantly reduced by burning treatments. The effect of "annual burning" on the activity of this enzyme was more pronounced than the "periodic burning". Sulfatase and urease activities were not affected by "periodic burning". "Annual burning", however, significantly reduced the activity of these enzymes (Table 1).

In summary, this experiment indicates that burning the forest floor debris reduces the rate of biochemical reactions by reducing the activities of most soil enzymes. Therefore, phosphorus, nitrogen, sulfur, and carbon dynamics within the forested ecosystem are significantly affected by burning. The effect of "periodic burning" on enzyme activities is generally less severe but, nonetheless, significant.

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Table 1.—Effect of long-term prescribed burning on selected enzyme activities

| Treatment | pH | Organic-C(%) | acid phos* | α-glu* | β-glu* | sulfatase* | urease† |
|---|---|---|---|---|---|---|---|
| Control | 4.8a†† | 1.0a | 125a | 12.4a | 33.5a | 66.8a | 255a |
| Annual burn | 4.8a | 0.9a | 96c | 9.6b | 32.6a | 55.4b | 170b |
| Periodic burn | 4.7a | 1.0a | 117b | 10.4b | 31.0a | 58.0b | 238a |

* μg*p*-Nitrophenol released $g^{-1}$ soil $hr^{-1}$ at 37 °C. Phos=phosphatase; Glu=glucosidase.
† μg Ammonium N released $g^{-1}$ soil/2 hr.
†† Means within each column followed by the same letter are not significantly different ($P \leq 0.05$) by Duncan's Multiple Range Test.